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Recognition of Facial Expressions With Respect to Navarasas in Bharathanatyam Styles Using Neural Network

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Abstract: *This research aims at developing an intelligent system which can recognize facial expressions related to human beings. Six universally accepted prominent emotions such as anger, fear, happiness, disgust, sadness and surprise along with neutral ones are recognized. In addition to this, emotions in Bharathanatyam, a classical dance style of south India is also studied in this paper by using neural network. Background subtraction method, face masking method and forward back propagation methods are used to train the neural network to recognize the faces. Results are found to be very encouraging. We hope this would open up a new window to the face recognition field.*

Key words: *facial expressions, neural network, bharathanatyam, feature selection, back ground propagation*

I. INTRODUCTION

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. It is a type of signal dispensation in which input is image and output may be an image or characteristics associated with that image. Main objective of the image processing is to observe the objects which are invisible or to create a better image or to search number of objects in an image and to distinguish them.

Humans are very good at recognizing faces and complex patterns. Even a passage of time doesn't affect this capability and therefore it would help if computers become as robust as humans in face recognition. Face recognition system can help in many ways. The six universally accepted expressions were analysed [10],[11] with respect to Japanese faces and are even compared with the expressions of Indian faces. Recently [12] the authors have analyzed facial expressions with respect to bharathanatyam, a classical dance style of south India.

Human life is a rich fabric which gains color and feel amidst the series of happenings that shape it. These actions that characterize every day as well as the extraordinary happenings make life further interesting while evoking feelings in human being. These feelings are the emotions or rasas, which indeed offer life colours and pattern. Rasas thus define the unedited realities of life amidst their vibrancies of emotion. The theory of Indian art is housed within the rasas as expounded by Bharata Muni in Natyasastra [1] and Nandikeswaran [2] in Abhinayadarpana. A rasa is the essence or a dominant mental state evoked in the audience by the performer. Rasa is created by bhavas. Bhava is the permanent mood and rasa is an expression of it. So as an example, when bhaya (fear) is the bhava, the rasa created is bhayanaka. Indian masters have identified nine rasas or Navarasas and we see that man lives his life through these nine basic expressions. A study of the Navarasas helps us understand basic human emotions and human psyche. The Navarasa, in the Indian scriptures refer to the nine expressions that humans often show. These are shringara, hasya, karuna, roudra, veera, bhayanaka, bheebhatsya, wonder or adbhutha and shantha.

Recognition of facial expressions started extensively since early nineties. Research in social psychology has demonstrated that facial expression is one of the major modality in human communication. Over the past two decades, a considerable amount of effort has been put to analyze the facial expressions from images by categorizing the face images into six basic types of expressions [1]. Estimation of the expressional intensities of the facial images is also studied [2]. Since, the display of a particular expression varies from person to person, it is not easy to achieve very accurate facial expression analysis. Several researches attempted to recognize even minute changes in facial expressions based on the Facial Action Coding System (FACS) [3]. Most of the early works identified the characteristics of facial motion and deformations based on human observations. Statistically determining the importance of different characteristic regions in the face would be very beneficial to facial expression analysis. Tothisend, Zhaoetal. [4] proposed to use Ada Boost on the LBP-TOP features to identify the very important expression-related characteristic features for expression recognition. It determines the location, resolution of the discriminative features and also the appearance information. Likewise, Tanetal.[5] have proposed the adaptively weighted sub- pattern PCA method that extracts features from the sub-patterns of

face images. Zafeiriou and Pitas [6] used the elastic graph matching (EGM) for selecting discriminative facial and marks for facial expression recognitions. So far a through survey of the literature reveals that no work pertaining to the present topic of research is available. Therefore the present investigation is carried out to through light on the subject of research.

II. FORMULATION OF THE PROBLEM

The data used for recognition and testing the navarasa facial expressions with respect to bharathanatyam styles was from the Nrithyaganga school, a performing centre at Nagarabhavi, Bangalore, Karnataka, India.. The data set contains 281 samples of gray scale images. The size of each image is 256X256. The data base was created by us using Sony cyber shot camera with 12.1mega pixels resolution and the sample of images are as shown bellow Figure 1.

Figure 1 **Data set used to test recognition of images**

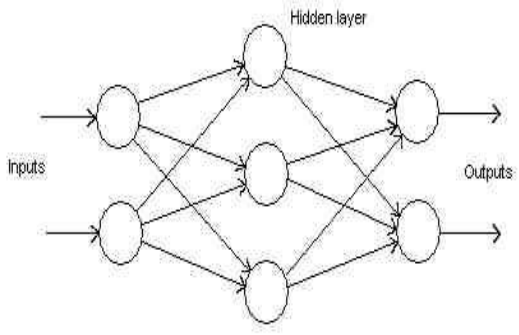

Figure 2 A generalized three layer neural network architecture

III. METHODOLOGY

Complex input/output relationship could be well captured and represented with the help of wonderful data modeling neural network tool which is represented by weighted interconnections associated with the processing elements. The information that is used by the neural network for finding the solution of the problem is represented by these weights. Actually these are non-linear function performed by the neural network and are considered as parameters. The most popular algorithm for multi-layer perceptron is the Back propagation algorithm. The structure of which is systematic updating the synaptic weights of multi-layer perceptron (MLP) networks. The minimization of the global error on the output layer is achieved by the supervised learning based on the gradient descent method. The performance of this algorithm involves two stages viz., feed-forward and feed-backward. In the first phase in response to the input pattern the outputs are generated. While in the second phase, in order to reduce the error, the synaptic weights are updated by back propagating to the hidden layer the errors computed in the output layer. This learning process terminates when the error associated with the output layer is sufficiently small .is repeated until the output error value, for all patterns in the training set, are below a specified value. The neural network architecture as shown in Fig.2 was used in the present study consists of three layers viz., (i) an input (ii) a hidden and (iii) an output layers. The number of neurons in input layer is 9 with adding a bias neuron. By varying the number of neurons in the hidden layer, the optimum result was obtained. The variations are 9, 45, and 90 neurons plus one bias. The last layer is output layer has 9 neurons in accordance with the amount of target researched. The activation function for hidden and the output layers are sigmoid bipolar, sigmoid respectively. This is because the expected output value is binary ie,.0 or 1.

Learning rate is also varied (0.25 and 0.5). The target of error and maximum epoch are 0.0001 and 1000 respectively. Table I provides information about the configuration of neural network output and its interpretation.

IV. EXPERIMENTS AND RESULTS

After registering all training set images, optimal neural network architecture was determined. Table II shows the testing result by varying the neural network parameters. From this table, it is clear that the number of neurons in hidden layer influences the training time. The best performance of experiment is 85.89%, Neural network architecture will perform optimum if the number of neurons in the hidden layer is 12 and the learning rate is 0.5. So, the neural network architecture was chosen to be implemented in the facial expression recognition system with respect to navarasa in bharathanatyam classical dance.

Node 1 sringar	Node2 Adbuta	Node 3 Bhayanaka	Node 4 Hasya	Node 5 Karuna	Node 6 Veera	Node 7 Raudra	Node 8 Bhibatsa	Node 9 Shanta	NN output
1	0	0	0	0	0	0	0	0	sringar
0	1	0	0	0	0	0	0	0	Adbuta
0	0	1	0	0	0	0	0	0	Bhayanaka
0	0	0	1		0	0	0	0	Hasya
0	0	0	0	1	0	0	0	0	Karuna
0	0	0	0	0	1	0	0	0	Veera
0	0	0	0	0	0	1	0	0	Raudra
0	0	0	0	0	0	0	1	0	Bhibatsa
0	0	0	0	0	0	0	0	1	shanta

Table I configuration of neural network results and its interpretations

I /O	Sringar	Adbuta	Bhayanaka	Hasya	Karuna	Veera	Raudra	Bhibatsa	Shanta
Sringar	10	0	0	2	0	0	0	0	0
Adbuta	0	8	2	0	0	0	1	0	0
Bhayanaka	0	0	7	0	0	1	2	0	0
Hasya	2	0	0	9	0	0	0	0	0
Karuna	0	0	0	0	8	0	0	2	1
Veera	0	0	0	0	0	9	2	0	0
Raudra	0	0	0	0	0	1	8	0	0
Bhibatsa	0	0	0	0	2	0	0	7	0
shanta	0	0	0	0	2	0	0	0	10

Table II Confusion matrix of facial expression recognition of training set

Number of Neurons in hidden layer	α	Result			
		MSE	Number of Images successfully recognized		Recognition rate %
			Training set	Testing set	
9	0.25	7.7895e-005	108	45	83.689
45	0.25	7.3323e-005	108	40	84.670
90	0.25	7.6894e-005	108	48	85.890
9	0.5	7.5674e-005	108	40	84.213
45	0.5	7.5487e-005	108	45	84.112
90	0.5	4.9785e-005	108	42	82.697

Table III. Testing results by varying the neural network parameters

I /O	Sringar	Adbuta	Bhayanaka	Hasya	Karuna	Veera	Raudra	Bhibatsa	Shanta
sringar	10	0	0	2	0	0	0	0	0
Adbuta	0	8	2	0	0	0	1	0	0
Bhayanaka	0	0	7	0	0	1	2	0	0
Hasya	2	0	0	9	0	0	0	0	0
Karuna	0	0	0	0	8	0	0	2	1
Veera	0	0	0	0	0	9	2	0	0
Raudra	0	0	0	0	0	1	8	0	0
Bhibatsa	0	0	0	0	2	0	0	7	0
shanta	0	0	0	0	2	0	0	0	10

Table IV. Confusion matrix of facial expression recognition of testing set

The confusion matrices of the performances of experimental result between training and testing set are recorded in Tables III and IV. In Table II, testing results by varying the neural network parameters are provided. All the expressions of training set are successfully recognized, meanwhile not all expressions of testing set were equally well recognized by the system. This may be because all the performers were not equally good in giving all the expressions

V. CONCLUSIONS

In this paper, a neural network based facial expression is recognized with respect to the nine modes of emotions pertaining to Bharathanatyam a classical dance form is studied. The proposed system achieves a recognition rate of 84%. Total number of images which have been trained and successfully recognized is 108 images; whereas images were not trained that successfully recognized are 45 images. We have yet to implement the false positive rate for every expression. The present work is innovative with respect to an art and culture in the sense that the neural network approach is applied for the first time to certain aspects of performing art. The result provides

an excellent platform for future investigation. We will take forward our work to recognize image of these kinds in a video also.

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